

**RTCA Special Committee 186, Working Group 5**

**ADS-B UAT MOPS**

**Meeting #8**

**Assumptions for Simulating Ground Station Performance in a Severe  
DME Environment**

**Presented by Chris Moody**

<b>SUMMARY</b>
<p>This paper presents the spectral characteristics of an operational DME station and the rejection response possible from a cavity tuned filter that could be used at a UAT ground station to reject DME interference. The paper proposes some simplified conditions that will allow simulation of UAT ground station performance in a severe adjacent channel DME environment considering the spectral characteristics of the DME beacon and the performance that should be possible with a practical cavity tuned filter.</p>

## 1.0 Background

Network level simulations are being used to assess UAT performance under various conditions. One condition to be investigated is that of a ground station receiver sited in a worst case situation: at the same airport as a DME/TACAN station operating on the adjacent channel of 979 MHz.

The objectives of this paper are as follows:

- to postulate a method for mitigating some of this adjacent channel interference to the UAT ground station through use of a tuned cavity filter.
- To propose an interference condition for simulation of ground station operation based on the characteristics of the tuned cavity filter, and the spectrum of the adjacent channel DME signal

## 2.0 DME Spectrum

Attachment 1 shows the spectrum of a DME measured off the air, using a 10 kHz resolution bandwidth. This DME was operating at 1161 MHz, but for illustration the axis is annotated assuming the DME were operated at 979 MHz. The annotation also shows the  $\pm 500$  KHz that is considered the UAT “in-band” region around the UAT center frequency (978 MHz) where the UAT desired signal must pass with minimal attenuation. The DME spectrum is down at least  $-40$  dBc in the UAT in-band region.

## 3.0 Tuned Cavity Filter

Attachment 2 provides information on a notch cavity filter designed to protect receivers against strong interference from pager systems transmitting at 929 MHz. This filter features some degree of tunability by the user, both in terms of the notch frequency and notch width. Figure 3 from the second page of Attachment 2 illustrates a notch tuning condition closely matching that desired in the UAT ground station application. The characteristics of the notch (translated up 50 MHz) are a close match for the DME spectrum, but slightly narrow for a perfect match. (We assume the characteristics of this filter could be translated in frequency upward by exactly 50 MHz.)

## 4.0 Assumptions

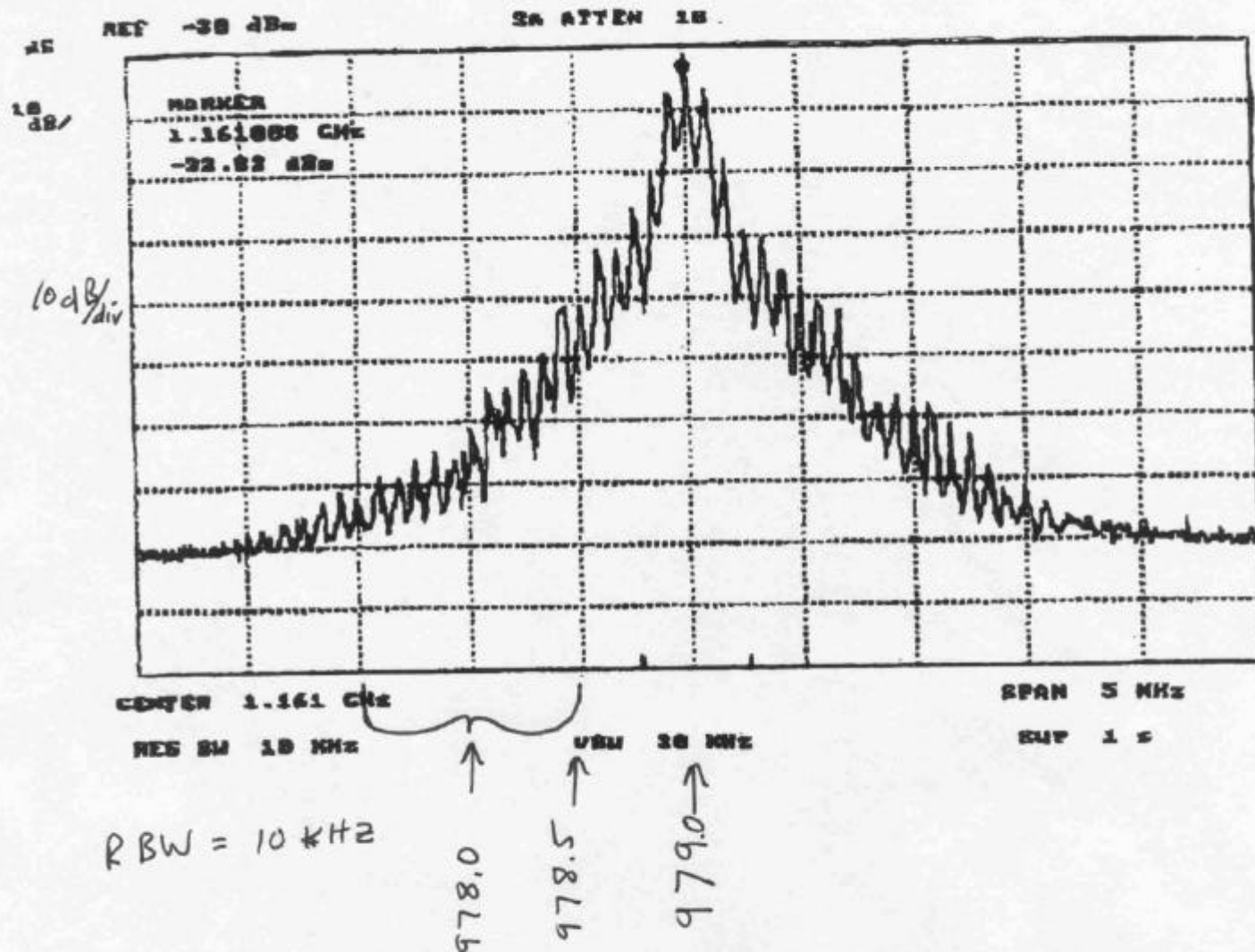
- a) DME/TACAN is at 979 MHz and operating at 10 kW ERP.
- b) Siting will allow for at least 1000' separation between the DME/TACAN and the UAT ground station.
  - Assumptions a) and b) above result in a DME signal level of approximately  $-10$  dBm at the UAT ground station.
- c) The notch characteristic of a viable cavity filter could be matched well to the spectrum of a DME with a small filter insertion loss in the UAT passband ( $< 5$  dB total)
- d) The filter would not significantly distort the desired UAT signal such that reception performance would be affected.
- e) The cavity filter in the UAT ground station will reduce the DME out of band signal to a level where the in band portion provides the dominant effect on the receiver.

## 5.0 Proposal

Given the filter and DME characteristics provided and the assumptions stated—that for simulation purposes—the use of a practical cavity notch filter creates the following effective conditions:

- a) That the effective interference environment can be modeled as an “on channel” DME interferer at a level of  $-50$  dBm ( $-10$  dBm  $-40$  dBc) at the prescribed pulse pair rate.
- b) That a 5 dB additional reduction in sensitivity be included to cover the combined loss effects of the filter.

Horn antenna, 13 ft cable, filter, 20 dB amplifier.



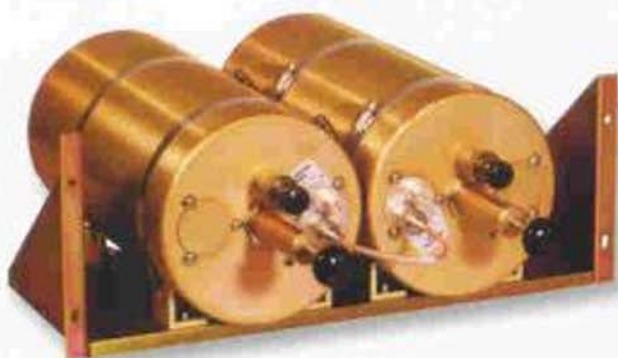
Measurement of FAA DME spectrum off the air  
by Volpe



## MAS Receive Filter 928/952 MHz



**Filters: Vari Notch 890-960 MHz**



Multiple Address Systems (MAS) provide alarm, control, interrogation, and status reporting communications in the utilities, petroleum, securities, and paging industries. While these communications are often critical, in some cases the 928-929 MHz master receive frequencies have little or no guard band against transmit 929-932 MHz paging frequencies.

### A Low Cost Solution To Paging Interference

TX RX offers a simple, low cost solution designed specifically to combat paging interference. Model 15-88-12-DM is a dual cavity filter using our patented Vari-Notch<sup>®</sup> circuit design. This design combines the low loss and close frequency spacing advantages of notch filters with the broad isolation and selective pass characteristics of bandpass filters. The result is a selective filter assembly capable of providing attenuation to frequencies as close as 400 KHz.

### Superior Construction For Stable Performance

All TX RX cylindrical filters are constructed with 1/10th inch thick seamless aluminum pipe wall. The heavier gauge material contributes to a more durable filter less likely to detune than typical thin-walled copper resonators. To ensure optimal continuous surface contact at high current points, a 1/4" thick end-cap is heliarc welded to the cavity shell, helping eliminate noise generation and the need for periodic retuning. The stationary and moveable tuning probes are silver plated to minimize erratic tuning behavior, noise, high loss, and degraded selectivity. Rotatable loop assemblies allow for field changing selectivity/insertion loss characteristics.

### Converts Easily To Other Filter Types

An important feature standard on most TX RX cavity filters is their convertibility. By simply "dropping in" a new loop assembly, a Vari-Notch filter can be converted to a bandpass, T-Pass<sup>®</sup>, or Series Notch<sup>®</sup> filter type.

### Maximum Selectivity, Broad Operational Range

To illustrate MAS applications, specifically the 928-929 MHz master receive band, the curves on the reverse side are organized with figures 1 through 4 tuned to pass a specific frequency and reject 929.000 MHz, while figures 5 and 6 are "stagger tuned" on the reject side to produce a wider reject window.

Another important feature of model 15-88-12-DM is its broad operational range. The pass/reject characteristics of this filter are relatively flat over the entire 890-960 MHz spectrum.

### High-Pass or Low-Pass, Transmit or Receive

Simple field tuning is all that is required to make this filter either high-pass or low-pass. For transmit applications with pass/reject separations greater than 500 KHz, the maximum continuous power rating is 400 Watts. For separations between 250 and 500 KHz, maximum continuous power is limited to 250 Watts.

### Technical Specifications

Model 15-88-12-DM	
Frequency Range	890-960 MHz
I.L. / Rej. / Sep.	1.0 dB / >60 dB / 1 MHz
I.L. = Insertion Loss	1.4 dB / >50 dB / 600 KHz
Rej. = Notch Depth	1.4 dB / >45 dB / 500 KHz
Sep. = Pass/Reject Separation	1.4 dB / >39 dB / 400 KHz
Selectivity Characteristics	refer to applicable curves on reverse side
Nominal Impedance	50 Ohms
Return Loss (VSWR)	-20 dB (1.22:1)
Temperature Range	-30° to +60° C
Connectors	N-female
Dimensions*	
Inches	7.25H x 19W x 20D
Centimeters	18.4H x 48.3W x 50.8D
Weight, lb (Kg)	17 (9.1)

\*Depth dimension will vary based on pass frequency tuning. With a pass frequency of 890 MHz, depth is approximately 17.5" (44.5cm), and at 960 MHz depth is approximately 23" (58.4cm).

### Versatile Mounting Options

The mounting option shown is a standard configuration. By reversing the cavity filters on the deck and flush mounting the filter bases with the deck front edges, this same model can be used in a cabinet configuration. Other options such as wall-mount brackets and rack-mount bars are available.

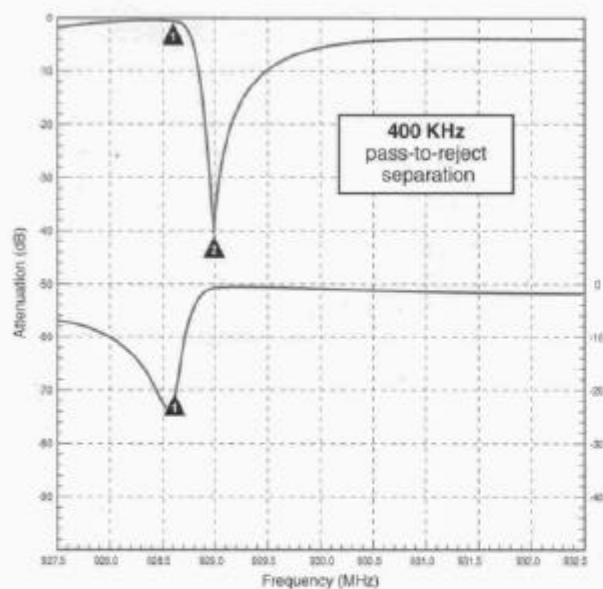
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TX RX SYSTEMS INC. 8625 INDUSTRIAL PARKWAY, ANGOLA, NY 14006

TELEPHONE 716-549-4700 FAX 716-549-4772 (24 HRS.) Email: sales@txrx.com Web Site: www.txrx.com

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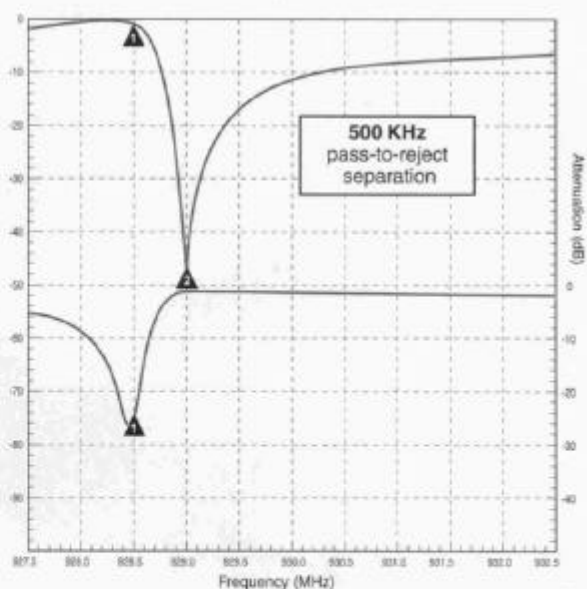


(fig. 1)

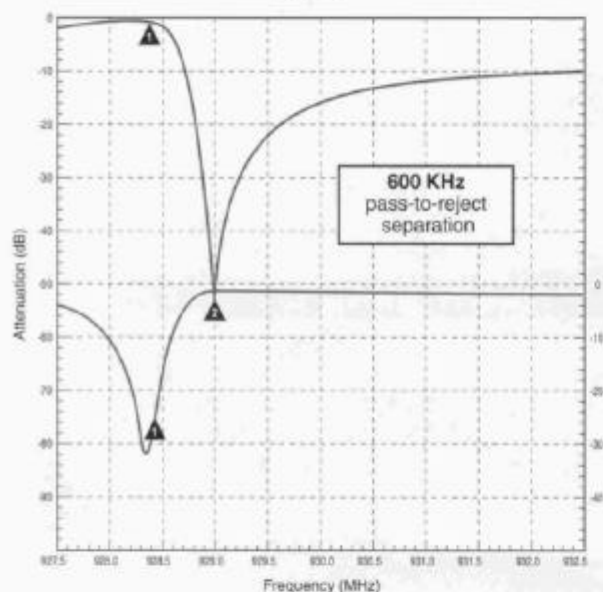
Selectivity Curves  
for Model:  
**15-88-12-DM**

← **Markers**  
1: 928.600 MHz  
1.4 dB Insertion Loss  
23.0 dB Return Loss  
2: 929.000 MHz  
40.8 dB Reject

**Markers** →  
1: 928.500 MHz  
1.4 dB Insertion Loss  
25.0 dB Return Loss  
2: 929.000 MHz  
48.0 dB Reject



(fig. 2)

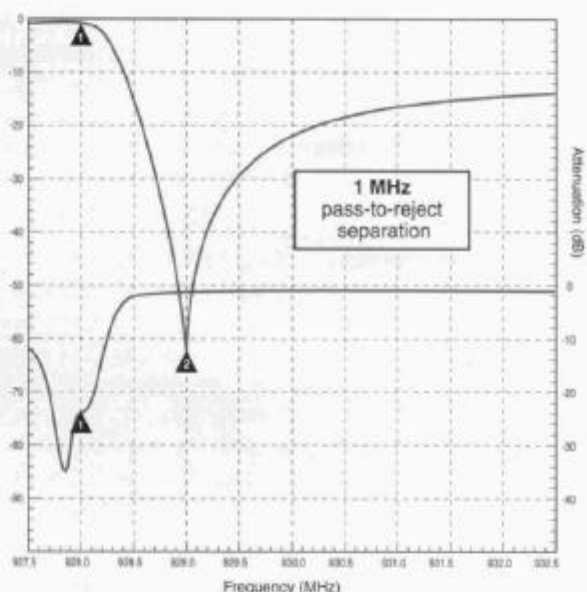


(fig. 3)

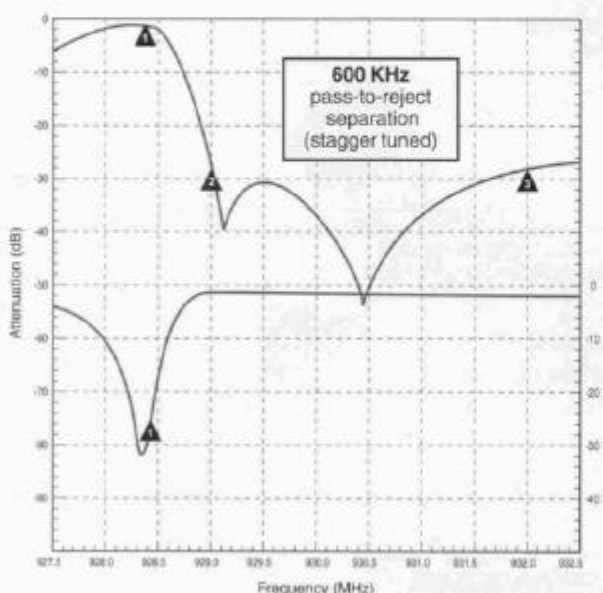
Selectivity Curves  
for Model:  
**15-88-12-DM**

← **Markers**  
1: 928.400 MHz  
1.4 dB Insertion Loss  
27.0 dB Return Loss  
2: 929.000 MHz  
54.5 dB Reject

**Markers** →  
1: 928.000 MHz  
1.0 dB Insertion Loss  
24.8 dB Return Loss  
2: 929.000 MHz  
63.0 dB Reject



(fig. 4)

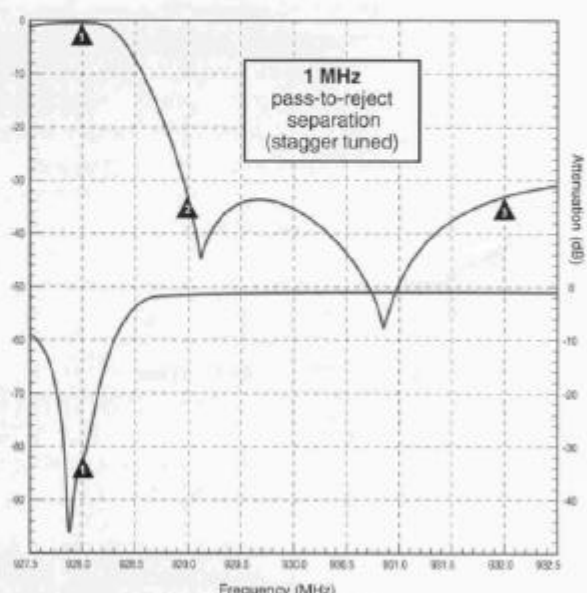


(fig. 5)

Selectivity Curves  
for Model:  
**15-88-12-DM**

← **Markers**  
1: 928.400 MHz  
1.4 dB Insertion Loss  
29.0 dB Return Loss  
2: 929.000 MHz  
28.0 dB Reject  
3: 932.000 MHz  
28.0 dB Reject

**Markers** →  
1: 928.000 MHz  
1.0 dB Insertion Loss  
32.5 dB Return Loss  
2: 929.000 MHz  
33.0 dB Reject  
3: 932.000 MHz  
33.5 dB Reject



(fig. 6)